2.2.7 Shell Mapping (Shaping)

In high speed modems each symbol transmitted contains a multiplicity of user data bits and coding bits. These bits are grouped into symbols and then mapped into a 2 dimensional signal constellation (as shown in Figure 2). The resulting signal point is then transformed to its analog signal equivalent for transmission over the analog voice channel. Shell mapping is a signal constellation mapping technique which attempts to distribute these signal points in the 2 dimensional space in such a way as to improve the resultant noise immunity by approximately 1 dB.

The concept is basically that an optimum constellation would be a spherical shape, however, this is not possible. Shell mapping approximates the spherical shape by mapping a square grid constellation to a near-spherical shape with guassian distribution of the signal points in the 2 dimensional space. The net effect is that the constellation is expanded, and the signal to noise ratio is improved by approximately 1 dB. The V.34 specification supports 2 levels of shell mapping which are related in terms of the resulting constellation expansion; 12.5% and 25% expansion.

Shaping

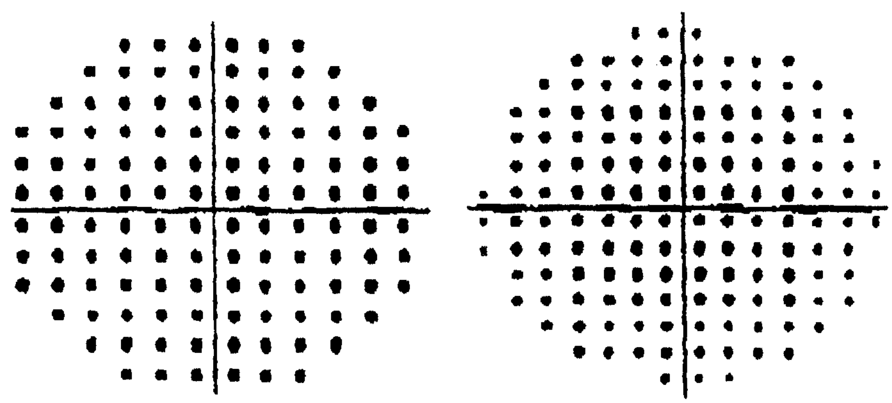

Figure 2

2.2.8 Warping (a.k.a. Non-linear Encoding)

Warping is another form of signal space coding specifically designed to combat the effects of signal dependent channel distortion also known as non-linear distortion or harmonic distortion. Non-linear distortion is present in all types of telephone channels and is by-in-large due to the PCM digital encoding of the analog signals. The non-linear nature of PCM coding compounded by the non-linear distortion introduced by analog components such as transformers and loading coils wreak havoc on these high speed modems.

Warping is a means of trading off signal to noise immunity for improvement in signal dependent distortion immunity. Figure 3 shows how warping does this.

Warping

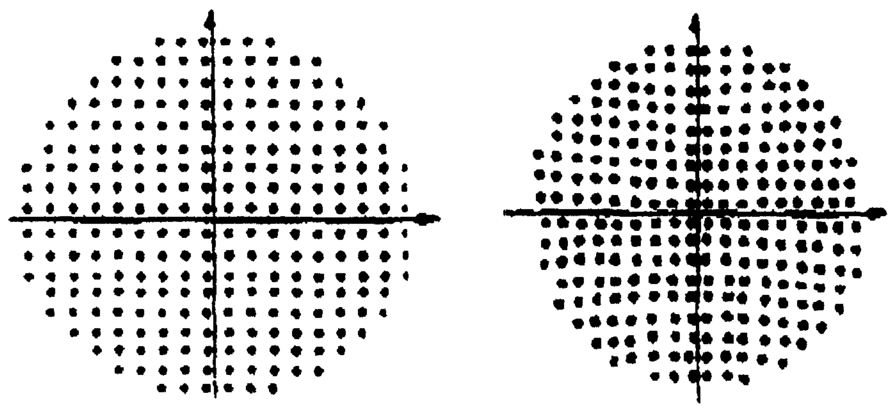

Figure 3

Knowing that non-linear distortion effects the outer constellation points more severely than the inner constellation points, the concept is to compromise the noise immunity of the inner points in favor of the more susceptible out points. The result is that the mean distance between points is increased in the outer fringe of the constellation (improving the immunity to all types of distortion, but particularly non-linear distortion) while the mean distance between the inner points is reduced.

2.2.9 Implementation

The V.34 standard does not mandate the full implementation of all features within the document. There are minimum requirements so that modems will function at the V.34 level but it leaves the details to the manufacturers. Each manufacturer decides which options will be used and in what order they will be processed. With this overview, it is understood that there are tradeoffs and compromises being made to optimize the V.34 modems performance with the connection over the network. The data rates will therefore be set to the highest possible level but to the lowest denominator of the modems for compatibility.

3. Transmission Parameters for V.34 Modems

With some understanding of what the V.34 modems are doing in response to the telephone network, a look at the transmission requirements is needed. The V.34 recommendation requirements are based on modem implementation and need to be redefined in telephony terms. The important parameters are bandwidth (frequency requirements), receive level, and noise requirement. As the V.34 overview tried to illustrate, the modems are designed to take the network variations into account and optimize the modem's performance.

3.1 Bandwidth Requirements for Data Rate Selection

The ITU Recommendation in this section is called Carrier Frequencies. It takes several tables and calculations to put it into terms that make sense in the telephone world. The table below shows the relationship between symbol rate, bandwidth and data rate. Symbol rate is the term now used to express baud rate. Each symbol encodes as many as nine (9) bits of data which yields the data rate. Each symbol rate except 3429 has two center frequencies to chose from and they are called high and low. There is approximately a 200 Hz difference in the bandwidth used. This is to compensate for frequency roll-off at either the high or low ends of the spectrum.

Symbol Rate per sec		Center Frequency	Bandwidth Requirements	Maximum data Rate Kbps
2400	Low	1600 Hz	400 - 2800 Hz	21.6
	High	1800 Hz	600 - 3000 Hz	21.6
2743 •	Low	1646 Hz	274 - 3018 Hz	24.0
	High	1829 Hz	457 - 3200 Hz	24.0
2800 •	Low	1680 Hz	280 - 3080 Hz	24.0
	High	1867 Hz	467 - 3267 Hz	24.0
3000	Low	1800 Hz	300 - 3300 Hz	26.4
	High	2000 Hz	500 - 3500 Hz	26.4
3200	Low	1829 Hz	229 - 3429 Hz	28.8
	High	1920 Hz	320 - 3520 Hz	28.8
3429 •		1959 Hz	244 - 3674 Hz	28.8

• Optional Symbol Rate

Telephone tariff requirements are usually written around 300 to 3000 Hz. As the table illustrates, V.34 modems go well beyond these numbers. In reality, the network has more bandwidth than the tariffs state, but there are no guarantees. Different transport systems will limit the bandwidth. While this does not effect voice connections, it will change the performance of a V.34 modem. It should be understood that these modems are probing the very limits of the telephone spectrum and trying to adapt to the conditions that are there.

3.2 Receive Level (Carrier Detect)

The ITU recommendation on threshold levels for carrier detection is a level greater than -43 dBm. This is the modem's term for receive level. It has been observed that most V.34 modems need a level of -40 dBm at the high end of the bandwidth to set the symbol rate and bit rate. For example, if a modem registers a level of -42 dBm at 3400 Hz, then it would select a symbol rate of 3200 and use the lower center frequency of 1829 Hz. The data rate would be set at 26.4 Kbps if all other parameters were adequate.

3.3 Noise Requirement

The ITU V.34 recommendation does not directly address the noise requirements. It was necessary to check with modem manufacturers. As the overview indicated, the constellation of the V.34 modem is very compact. Signal-to-Noise Ratio (SNR) was the parameter that was needed to be met. The lower limit that has been quoted is 32 to 34 dB. This is the lowest SNR needed to be able to connect at 28.8 Kbps on V.34 modems. Most tariff requirements are written to guarantee only a 24 dB SNR. The network has improved and this number is achieved in the switched network, but older types of network elements are still deployed and, as such, a SNR of 32 or greater cannot be guaranteed.

Bellcore's TM-25203[7] reported signal-to-noise ratios for digital connections. When an analog-to-digital (A/D), then a digital-to-analog (D/A) conversion occurs, there is a SNR of 36 to 38 dB measured through the transport. A universal digital loop carrier (UDLC) is a typical example found in the network. Two of these transports would result in a SNR of 33 to 35 dB. When a local switch and cable is added into the equation, the SNR would fall to 32 or less. This would drop the data rate one level.

4. Local Observations

There have been reports from local companies having to do with short local loops. It was determined that loops with less than 3 dB of loss were running lower than expected data rates. Through trial and error, performance was sometimes improved by adding additional loss to the loop. The underlying factor was poor return loss and some modems could not cancel out the near end echo that was produced. The modems would interpret the echo as noise and adjust the data rate down to compensate. This is a fundamental issue that has been taken up by the EIA/TIA standards body on analog modems. A new network model has been proposed to more accurately reflect the actual switched telephone network.

These same short loops can generate higher current through some modem transformers and cause poor performance. Customers have had to add balanced resistors to the line to reduce the current flow through their modems. Another issue is with modems that have electronic termination which regulates the current. If these modems are connected to a digital loop carrier (DLC) channel unit that adjusts transmission levels based on loop resistance, the modems will receive a hot level and have return loss problems.

The customer's home environment can effect V.34 modem performance. Customer premises wire can pick up noise when twisted cable pairs is not used. Also, a direct run from the protector may give some improvement. The other source of noise can come from other telephone sets on the same line as well as Fax machines and answering machines. Removing these devices from the data line could help in improving data connections.

5. Modem Testing

5.1 System Configuration

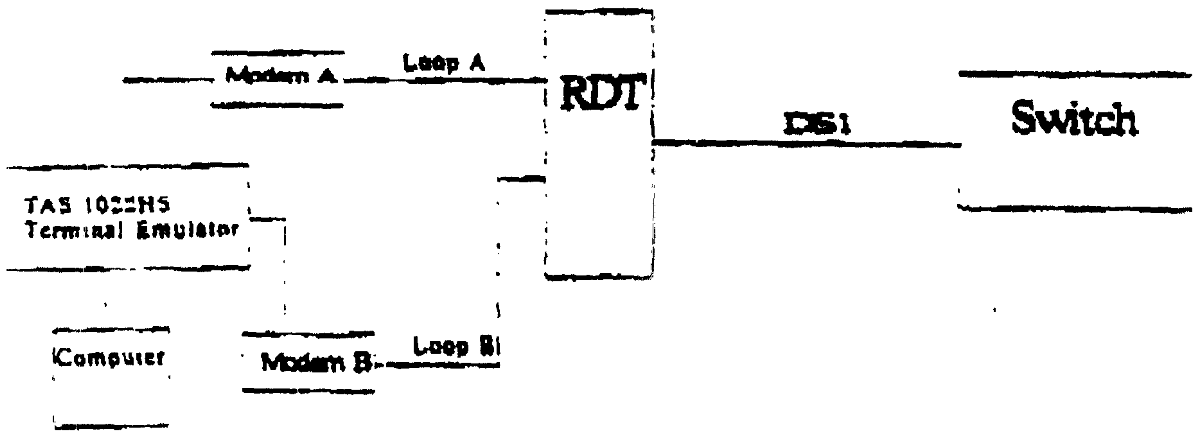

Figure 4 Modem Test Configuration

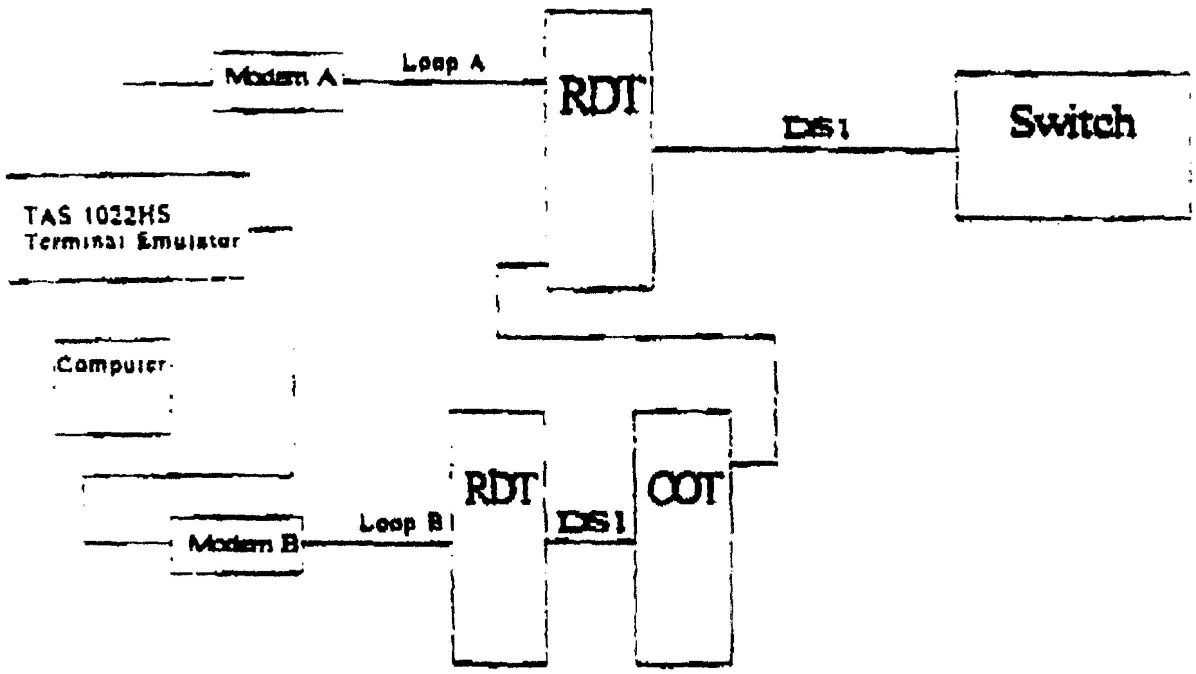

Figure 5 Modem Test Configuration with Additional Conversion

The test setups detailed in Figures 4 and 5 involved a SLC 96 COT and RT with appropriate POTS and UVG LUs. The access system in Figure 4 was installed as integrated DLC with the switch located at the Bellcore facility in Red Bank, NJ. The DLC systems were located at the Bellcore facility in Morristown. Bellcore corporate network MUXs were used for the DS1 connections between Morristown and Red Bank. In all cases, each system was externally timed from a Stratum 1 level cesium clock source.

5.2 Test Procedures

The goal of these tests was to determine the maximum data rates under different conditions. A file was transferred between modems to insure a valid connection.

A Telcom Analysis Systems TAS 1022HS terminal emulator was used to control the modems. Procomm PLUS for Windows was used to communicate with the TAS 1022HS. A script file, written in Procomm's Windows Aspect Script (WAS) language was used to automate the TAS 1022HS dialing, file transfer and to capture test results.

5.3 Results

5.3.1 Tests with PCM Conversions

The table below shows results of tests where the number of analog to digital conversions and the loop lengths are varied.

Number of conversions	A side Loop	B side Loop	dB Loss at 1004 Hz	dB Loss at 3604 Hz	A Data Rate	B Data Rate
1	na	na	4.6	13.8	28.8	28.8
1	3 Kft	3 Kft	7.7	18.4	28.8	28.8
2	3 Kft	1.5 Kft	10.0	30.2	21.6	24.0
2	6 Kft	1.5 Kft	10.5	33.4	21.6	24.0
2	9 Kft	1.5 Kft	12.0	36.2	21.6	24.0
2	12 Kft	1.5 Kft	13.5	39.2	19.2	24.0

As seen in the table, one digital conversion resulted in a maximum connect rate of 28.8 Kbps. However, there was either no loop attached or a very short loop was present. The result was little frequency roll off at the high end. When an additional conversion is present, the data rate drops in both directions. There is no additional effect with loop length until after the 9 Kft section is reached. The level at 3604 Hz starts to gets closer to the -40 dBm point at 9 Kft and at 12 Kft, it is close enough to it that the data rate goes down another level.

5.3.2 Local Cable Tests

Below is a table which shows the connect rates when using the fifteen loops found in TR-NWT-000393[1]. These loops were used to determine the effects of different cable lengths and bridged-taps (BT) on modem connect rates. They are actual cables located in the Bellcore Morristown Lab. The B side of the test configuration was set at 1.5 Kft of 26 gauge cable to represent an Internet Service Provider on a short loop, either to a local switch or a Digital Loop Carrier (DLC). The A side represented typical residential users. Only one digital conversion is present in this set of tests

Loop #	Length of A Side (Kft)	BT (Kft)	dB Loss at 1004 Hz	dB Loss at 3604 Hz	A Receive Data Rate	B Receive Data Rate
15	12	0	11.4	26.9	26.4	26.4
14	14	3.5	11.4	28.5	26.4	26.4
13	12	3	11.2	27.6	26.4	26.4
12	13.5	0	11.3	27.5	26.4	26.4
11	12	1.5	11.3	27.3	26.4	26.4
10	16.5	1	12.3	29.3	26.4	26.4
9	10.5	4.5	11.4	27.6	26.4	26.4
8	16	1	12.5	29.6	24.0	24.0
7	13.5	0	12.2	28.8	26.4	26.4
6	17.5	1	12.8	30.6	24.0	26.4
5	15	1.5	12.3	29.4	24.0	24.0
4	17	0	13.0	30.4	24.0	24.0
3	15	3	13.0	31.3	24.0	24.0
2	16.5	1.5	13.5	31.6	24.0	26.4
1	18	0	14.3	32.7	21.6	24.0

The results indicate that bridged-tap does not directly affect the data rates of V.34 modems. It is more dependant on the actual length of the cable. The data rate is constant between 10.5 Kft and 16.5 Kft. The data rate goes down one level at 15 Kft and drops again at 18 Kft. The relationship is in the power loss at the high end of the spectrum. The B modem would be transmitting at a nominal level of -10 dBm. The receive level is then -36.9 dBm for loop #15 and -42.7 dBm for loop #1. The actual level is what is determining the data rate.

6. General Assumptions

With the observations and testing that has been done, some general assumptions can be made. To achieve a 28.8 Kbps connection on the Public Switched Telephone Network (PSTN), three conditions would always need to be met. One and two are non-loaded cables at both ends of the connection with a length of no more than 9 Kft. The third condition is only one A/D and D/A conversion on the connection. Any thing less than will probably result in a connect rate less than 28.8 Kbps. On the average, the majority of the V.34 modem users will realize a connect rate of 24.0 to 26.4 Kbps.

The table below could be used as an aid to determine the most optimistic data rate for a V.34 modem over the Intra LATA Network. It is assumed that there are no trouble conditions and all loops are within normal parameters. It is not advisable to attempt to assign relative values to the numbers.

Choose one item from each applicable category and place the number in the parenthesis in the value box to the right.

Customer loop	0-9 Kft NL (0) 18 - 24 Kft L (7)	9 - 12 NL Kft (1) 24-30 Kft L (10)	12- 18 Kft NL (3) > 30 Kft L (12) Loop Value =

Loop Cxr	No DLC (0)	IDLC (2)	UDLC (6) Loop Cxr Value =
Switch Type		Analog (0)	Digital (1) Switch Value =
Interoffice Facility	Digital Route (2)	Analog tandem (4)	B/B T-Cxr (6) Facility Value =
Switch Type		Analog (0)	Digital (1) Switch Value =
Loop Cxr	No DLC (0)	IDLC (2)	UDLC (6) Loop Cxr Value =
Customer loop	0-9 Kft NL (0) 18 - 24 Kft L (7)	9 - 12 NL Kft (1) 24-30 Kft L (10)	12- 18 Kft NL (3) > 30 Kft L (12) Loop Value =
Add the six values to obtain the Sum of Values			*Sum of all Values*=

Take the Sum of Values and find the range that identifies the most optimistic possible data rate for this connection.

0-6 = 28.8 Kbps   7-9 = 26.4 Kbps   10-13 = 24.0 Kbps   14-16 = 21.6 Kbps

17-20 = 19.2 Kbps   21-25 = 14.4 Kbps   26-30 = 9.6 Kbps

7. Conclusions

<u>The results of this report clearly indicate that V.34 modem performance will vary greatly over the switched telephone network.</u> This is due, in part, to the varied facilities that exist in the network, but on how modem manufacturers have implemented the V.34 recommendation.

The telephone network is made up of PCM links with A/D and D/A conversions. Each link will degrade a V.34 modem connection by one level due to the addition of quantization noise introduced by the μ-law encoding and decoding. When local cable is added to the equation, a length of more than 9 Kft or greater will degrade a modem connect rate due to the frequency roll-off at the high end of the spectrum. Therefore, if a telephone company had only digital switches, and all digital trunking between them and had only local cable that never extended 9 Kft, all their customers would be happily running their data lines at 28.8 Kbps. However, this environment does not exist at this time. Many modem users will have data connections at less than 28.8 Kbps but because of how V.34 modems operate, they will run at the most optimum rate possible.

8. References

1. ITU-T Recommendation V.34. *A Modem Operating at Data Signaling Rates of up to 28,800 bit/s for use on the General Switched Telephone Network an don Leased Point-to-Point 2-wire Telephone-type Circuits*, September 1994

2. TM-25202. *Engineering Guidelines For Facility Design to Meet Enhanced Data Conditioning Transmission Requirements*, September 29, 1995, Published by Bellcore

3. TR-NWT-000393, *Generic Requirements for ISDN Basic Access Digital Subscriber Lines*. Issue 2. January 1991. Published by Bellcore

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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	CC Docket No. 98-121
Application of BellSouth Corporation,	)	
BellSouth Telecommunications, Inc.	)	
and BellSouth Long Distance, Inc.	)	
for Provision of In-Region, InterLATA	)	
Services in Louisiana	)	

Exhibit S:
Carter Reply Testimony
CPUC Docket No. 93-04-003 (April 27, 1998)

Before the

PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

Rulemaking on the Commission's Own Motion to Govern Open Access to Bottleneck Services and Establish a Framework for Network Architecture Development of Dominant Carrier Networks.	)	R.93-04-003
Investigation on the Commission's Own Motion into Open Access and Network Architecture Development of Dominant Carrier Networks.	)	I.93-04-002

Reply Testimony

of

Ernest M. Carter

on behalf of

AT&T Communications of California, Inc.

and

MCI Telecommunications Corporation

April 27, 1988

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Ernest M. Carter. My business address is 5160 Parkstone Drive, Suite 190, Chantilly, VA 22021.

Q. BY WHOM AND IN WHAT CAPACITY ARE YOU EMPLOYED?

A. I am employed by Chantilly Telecommunications, Inc. as a telecommunications engineering consultant. Currently I am providing consulting services to MCI Telecommunications Corporation (MCI) and AT&T Communications of California, Inc. (AT&T) concerning outside plant infrastructure design, construction and costs of the local loop.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING?

A. I am testifying on behalf of MCI and AT&T.

Q. WHAT IS YOUR EDUCATIONAL BACKGROUND?

A. I graduated from the University of Alberta in Edmonton, Alberta, Canada with a degree in Electrical Engineering in 1962.

Q. WHAT IS YOUR BACKGROUND IN OUTSIDE PLANT ENGINEERING AND CONSTRUCTION?

A. I have over 31 years of experience with Bell Canada of which 21 years were directly related to outside plant engineering and construction. My experience is in territories ranging from metropolitan urban centers to small towns and rural territories including villages, farm land, mining communities, forestry industries, vacation and weekend home areas, bedroom communities and vast undeveloped areas.

I started my career with Bell Canada in 1962 as an outside plant engineer in Northern Ontario, a territory with urban centers ranging in populations from about 500 to 90,000 and a vast rural territory. My next position was in Interoffice Transport Engineering, where I was the engineer responsible for interoffice transport planning and provisioning for the Niagara and Hamilton territory. In 1965, I transferred to Corporate Headquarters where I worked as an engineer in the transmission group. I later transferred to the Corporate Headquarters Outside Plant Design group where I was responsible for preparing specifications for new products, dealing with suppliers and standardizing new products for terminals, feeder/distribution interfaces, loading coils and carrier apparatus cases.

In 1967-68, I attended an 18 month Operating Engineering Training Program at the Bell Laboratories in New Jersey. With the advent of solid state technology, this program was established by the Bell Operating Companies to provide training in the new technology. In 1968-1972, I was the District Staff Engineer at Bell Canada's Corporate Headquarters responsible for developing engineering methods, writing engineering and construction practices and performing engineering quality reviews. In this position I was also the engineering representative on an interdepartmental corporate operations review team and I was personally responsible for conducting the operational reviews for outside plant engineering. My later positions with Bell Canada included responsibility for Plant Expense Budget for Plant Operations for the Toronto Area Vice President, and District Outside Engineer for the downtown core area of Toronto, Ontario where I also was responsible for the conduit engineering and the interoffice transport outside plant engineering functions for all districts in the Toronto Operating Area. For three years, I was in charge of Bell Canada's Corporate Engineering Economic Division and was responsible for developing engineering economic study tools and conducting economic studies in support of regulatory activities and corporate investment decisions. I was thereafter appointed the Division Construction Manager for Northeast Ontario and was responsible for an area extending from the Quebec border to the Manitoba border, a distance of about 1000 miles. This was a new organization that I formed at the time when Bell Canada had undertaken a major five year program to upgrade service in non-urban areas. Later, I was appointed the Division Outside Plant Engineer for the same territory. In this position, the functions under my direction included Planning, Design, Records, BICS (Building Industry Consulting Service), Digital Loop Carrier (DLC) Provisioning, and right-of-way procurement. When the Engineering and Construction organizations were combined, I assumed responsibility for the new Engineering and Construction Division for a territory that included central and northern Ontario.

From 1985 through 1988, I was an Outside Plant advisor with BCI Inc. in Saudi Telecom responsible for advising and training the Saudi Telecom Managers for the Western Region of Saudi Arabia on all aspects of outside plant planning, design and construction. From 1988 through 1989, I was on a Corporate Task force charged with developing the expense budget funding criteria for all strategic business units. My primary responsibility was the expense budget funding for the outside plant and customer services functions. From 1989-94, I was the Operations Manager for Engineering and subsequently Engineering and Construction in eastern Ontario. Following my retirement from

Bell Canada in 1994, I worked for OPS Consultants, based in the State of Virginia, as an outside plant engineer.

Q. HAS YOUR BACKGROUND INCLUDED TRAINING AND EXPERIENCE IN THE DEPLOYMENT OF DIGITAL LOOP CARRIER TECHNOLOGY?

A. Yes. I was in charge of a major five year program undertaken by Bell Canada to upgrade non-urban service during the late 1970's. To implement that program, I began deploying large numbers of Digital Loop Carrier (DLC) as soon as that technology became an economically viable alternative to copper cables. A large part of the territory covered by the program was under my supervision and it included the territory with the greatest number of DLCs in Ontario. As a result, many of the provisioning methods and procedures that were developed in my organization became part of the standard operating procedures for Bell Canada in the province of Ontario. Also, following my retirement from Bell Canada, I worked for a consulting firm designing digital loop carrier systems for a Regional Bell Operating Company.

Q. PLEASE EXPLAIN HOW YOUR TESTIMONY IS ORGANIZED.

A. My testimony is organized as follows:

I - PURPOSE

II – COMPETITOR REQUIREMENTS FOR IDLC UNBUNDLED ACCESS

- Competitor Requirements for Unbundled IDLC (Integrated Digital Loop Carrier) Access
- Incumbent's proposal related to loops served by IDLC
- Response to Pacific Bell contention that IDLC does not support local competition.

III – UNBUNDLED ACCESS NETWORK ARCHITECTURES FOR IDLC

- How NGDLC (Next Generation Digital Loop Carrier) supports the forward looking local competition environment
- How DCS (Digital Cross-Connect System) supports the forward looking local competition environment

IV - SUMMARY OF METHODS FOR UNBUNDLED ACCESS TO IDLC

V - DLC (DIGITAL LOOP CARRIER) TECHNOLOGIES DEPLOYED BY THE INCUMBENTS

VI - RESPONSE TO MR. DEERE'S INTERPRETATION OF THE FCC'S LOCAL INTERCONNECTION ORDER

VII - RESPONSE TO MR. DEERE'S PROPOSED APPLICATION OF INTERCONNECTION/NETWORK ELEMENT REQUEST (INER) PROCESS FOR LOOPS SERVED BY IDLC

VII - RESPONSE TO MR. DEERE'S CLAIM ON THE INABILITY TO DISTINGUISH BETWEEN FEEDER AND DISTRIBUTION IN MANY CASES.

VIII – SUMMARY AND CONCLUSION

I - PURPOSE

Q. WHAT IS THE PURPOSE OF YOUR REPLY TESTIMONY?

A. The purpose of my testimony is to respond to the testimony of William C. Deere on behalf of Pacific Bell and the testimony of Mr. Larry Hartshorn on behalf of GTEC. Principally, I will address Mr. Deere's testimony setting forth Pacific's position that it will deny competitive local carriers unbundled access to the forward looking and highly efficient Integrated Digital Loop Carrier (IDLC) technology used in the local loop network. At the same time, I address Mr. Hartshorn's failure to include such access in the types of unbundled access GTEC proposes to offer. I also address Mr.

Deere's claim that in many cases it is difficult to determine the point of separation between the feeder and distribution segments of Pacific Bell's network.

Regarding unbundled access to subscriber loops served by the incumbent local exchange carriers using IDLC, my testimony shows that:

1. Access to the IDLC technology is critical to the development of local competition for regular telephone services (POTS) and advanced telecommunications services, such as Integrated Switched Digital Network (ISDN).
2. Both Pacific Bell and GTEC propose to deny new entrants access to IDLC. Instead, when a competitor purchases unbundled loops the incumbents serve using IDLC they propose to move them to "Universal" (not integrated) Digital Loop Carrier (UDLC) or copper facilities if available.
3. Loops served on IDLC allow a carrier to provide improved service quality at lower costs. Pacific Bell's and GTEC's strategy to deny competitors unbundled access to IDLC for such loops would degrade competitor service quality, increase competitor costs and provide the incumbents a distinct competitive advantage
4. Unbundled access using IDLC (Integrated Digital Loop Carrier) technology is technically feasible and more supportive than is access using UDLC (Universal Digital Loop Carrier) of a forward-looking environment which allows competitors to compete with Pacific Bell and GTEC to provide local service through the purchase of unbundled network elements.
5. Network architectures and methods for providing access to unbundled loops served on IDLC using Next Generation Digital Loop Carrier and older generation Digital Loop Carriers exist, that provide end-to-end digital transmission without intervening service degrading conversions to analog, which the incumbents should use to provide new entrants unbundled access to loops served on IDLC.

My testimony concludes with the recommendation that the Commission require Pacific Bell and GTEC to provide new entrants and their customers unbundled access to the same digital loop technology (IDLC) that Pacific Bell and GTEC utilize to serve their own customers. Otherwise the Commission will provide the incumbents a blatantly unfair advantage over competitors, frustrate the development of local competition and, thus, deny California consumers more choice of providers and lower prices for access to high quality telecommunications services.

II - COMPETITOR REQUIREMENTS FOR IDLC UNBUNDLED ACCESS

Q. PLEASE EXPLAIN THE DIFFERENCE BETWEEN IDLC (INTEGRATED DIGITAL LOOP CARRIER) AND UDLC (UNIVERSAL DIGITAL LOOP CARRIER), AND WHY ACCESS TO IDLC IS IMPORTANT TO THE COMPETITOR.

A. As shown in Exhibit EMC1, which illustrates both "Universal" and "Integrated" Digital Loops Carrier, Integrated Digital Loop Carrier (IDLC) consists of a Remote Digital Terminal (RDT) and a transmission link[1] that connects the RDT to the Integrated Digital Terminal (IDT) which is part of and provides the interface with the Local Digital Switch (LDS). The distinguishing characteristics of IDLC from UDLC is the absence of a Central Office Terminal (COT) which converts the digital signal to analog and is necessary when the local switch is analog.

IDLC permits end-to-end digital transmission of signals without any intervening conversion to analog which is inherent to UDLC. This avoids the transmission degradation caused by the analog conversion and dramatically reduces costs because it avoids the manual intervention for service provisioning that occurs with

[1] The current IDLC technologies use a fiber optic cable and SONET (Synchronous Optical Network) for the transmission link. In the past T1 Carrier on copper pairs were used for the transmission link.

UDLC and eliminates major investments. Not providing the new entrants access to unbundled loops using IDLC would cause competitors to suffer degradation in the quality and increased costs to provide basic telephony services and advanced telecommunication services which consumers increasingly demand.

Q. DO PACIFIC BELL OR GTEC, IN THE TESTIMONY OF MR. DEERE ON BEHALF OF PACIFIC BELL AND THE TESTIMONY OF MR. HARTSHORN ON BEHALF OF GTEC, PROVIDE THE COMPETITOR UNBUNDLED ACCESS FOR IDLC?

A. No. as stated on page 11, in the answer to Q29, Mr. Deere states that for customers served on IDLC , Pacific Bell will move the customer to a UDLC facility or to copper facilities, if available. If neither is available, Pacific Bell will install such facilities and the competitor will be responsible for the costs.

Similarly, GTEC does not offer competitors unbundled access to IDLC in any of the options for unbundled access to loops described in Mr. Hartshorn's testimony.

In my opinion, from an engineering perspective, Pacific Bell and GTEC are asking the Commission to condone anti-competitive discrimination by approving of their denial of competitor access to the high quality service capabilities and efficiencies of IDLC technology.

Q. ON PAGE 11 OF HIS TESTIMONY, MR. DEERE STATES THAT IDLC WAS NOT DESIGNED FOR THE "FORWARD LOOKING LOCAL SERVICE COMPETITIVE ENVIRONMENT." DO YOU AGREE?

A. No, I disagree with Mr. Deere. In the context of his testimony, it would appear Mr. Deere means by this that IDLC was not "designed" in contemplation of an environment which requires Pacific to provide competitors unbundled access to its network. That misses the point. Many components of Pacific's existing network were "designed" prior to passage of the Telecommunications Act and the existence of the requirement that incumbents provide unbundled access to their networks. The question now is, however, whether such unbundled access is technically feasible. As I explain later in my testimony, unbundled digital access to IDLC is currently technically feasible by a variety of means. If Mr. Deere is implying that forcing competitors to interconnect using UDLC is more appropriate for the forward looking local service competitive environment, that's simply not true. Foisting this older generation technology on competitors would impair the quality of transmission[2] received by competitor customers, incur service provisioning delays to competitor customers, make such service less reliable, and more than double the digital loop carrier and switch terminal investments necessary to provision such service. The following explains this in more detail.

Q. PLEASE EXPLAIN WHY UDLC IS NOT MORE SUITED THAN IDLC TO THE PROVISIONING OF UNBUNDLED ACCESS TO LOCAL LOOPS SERVED BY DIGITAL LOOP CARRIER?

A The following are the major reasons

1) UDLC was designed in the 1970's for an analog switching environment. In an analog switching environment it was necessary to convert the digital signal to analog to interconnect with the analog switch. However, the switches now are digital so it is redundant and counter productive to convert the digital signal from the digital loop carrier to analog.

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[2] The additional analog-to-digital conversion inherent to UDLC, affects the signal to noise ratio which impairs the quality of transmission, particularly for services using dial-up modems. There is marked

2) Converting the signal to analog, as is done by UDLC, requires the signal to be converted back to digital again because the local digital switch needs the digital signal. The competitor switches and transport network are also digital, so if the incumbent unbundles the loops using UDLC and provides the competitor an analog circuit, the competitor needs to convert the circuit back to digital to connect it to its switched network. In addition to being costly, this impairs transmission quality. The impairment is caused by a deterioration in the signal to noise ratio which has a serious affect on certain services, particularly those that use a dial-up modem, such as Internet Access.

3) Converting the signal to analog involves major additional and redundant investments. It requires:

   i) a COT (Central Office Terminal) to convert the digital signal to analog;

   ii) cabling and wiring to connect the analog circuits from the COT to the Main Distributing Frame;

   iii) a Main Distributing Frame (MDF); and

   iv) additional floor space, heating, and power.

4) When used with a local digital switch, UDLC also requires a major investment in switching equipment (AIU, Analog Interface Units) to convert the analog circuit back to digital. This equipment also causes a need for additional investments for associated cabling to terminate the analog switch ports at the MDF.

5) Because UDLC terminates the analog circuits at the MDF, it necessitates manual activities for service provisioning which increases costs and delays service provisioning.

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reduction in performance of modems used for Internet Access.

6) The additional equipment and wiring also adds noise and increases the probability of circuit failure which affects customers' transmission quality and service reliability.

7) UDLC is not designed to efficiently provision forward looking digital services, such as those based on ISDN.

Thus any suggestion that UDLC is appropriate technology and network architecture for the forward looking competitive environment is misleading. On the contrary, forcing competitors to access unbundled digital loops using UDLC would only serve to frustrate competition and allow the incumbents to perpetuate their local service monopoly and extend it into the market for the advanced, increasingly demanded, telecommunications services.

<u>III – UNBUNDLED ACCESS NETWORK ARCHITECTURES FOR IDLC</u>

Q. IS IT TECHNICALLY FEASIBLE FOR PACIFIC BELL AND GTEC TO PROVIDE UNBUNDLED ACCESS FOR LOOPS SERVED USING IDLC?

A Yes. Next Generation Digital Loop Carrier (NGDLC) and Digital Cross-Connection Systems provide the network architecture, features and capabilities to support unbundled access to loops served by digital loop carrier integrated with the local digital switch.

Q. PLEASE EXPLAIN NGDLC AND HOW IT SUPPORTS UNBUNDLED ACCESS TO LOOPS SERVED ON INTEGRATED DIGITAL LOOP CARRIER?

A. NGDLC became available in the 1990's and was made possible by 3 major technology developments.

- One, was the development of low cost fiber optic cables,

- Two, was the development of SONET technology which results in dramatic reduction in the cost of the digital loop carrier transmission technology,
- and three, Bellcore's development of the generic requirements for the next generation of IDLCs.

NGDLC is a GR-303 compliant digital loop carrier. The Bellcore Generic Requirements document, GR-303 defines the system requirements for the next generation of integrated digital loop carriers. These requirements were developed by Bellcore with the involvement of the digital loop carrier vendors and users, including the incumbents, and are aimed at current and forward looking service requirements and operating environments. Compared to the old TR-008 IDLC, the new generation digital loop carriers with an integrated GR-303 interface with the local digital switch provide a very powerful and efficient local loop network for the following reasons.

1. GR303 is optimized for ISDN services. ISDN can be provisioned essentially like POTS (Plain Old Telephone Service) services, whereas TR-008 (previous generation of IDLC) cannot provide ISDN services.
2. GR303 makes very efficient use of bandwidth and switch terminal capacity. It does this by assigning a channel to the customer on a call-by-call basis which means that GR-303 uses a fraction of the transmission capacity and switch terminal capacity previously required. For example, for an ISDN service, GR-303 requires less than one DS0 of bandwidth capacity compared to three DS0s (some use 2.25 DS0s) using conventional digital loop carriers.
3. GR303 is optimized for forward looking requirements for operations support systems which provide for highly automated, centralized and remotely located operations centers.

4. GR303 supports digital cross-connection functionality without intervening analog conversion for non-locally switched services, such as foreign exchange lines and non-switched services such as private lines.

Q. PLEASE IDENTIFY THE CRITICAL FEATURES AND CAPABILITIES OF NGDLC THAT FACILITATE UNBUNDLED ACCESS TO LOOPS SERVED BY INTEGRATED DIGITAL LOOP CARRIER.

A. End-to-End Digital Transmission

The critically important requirement for competitors to compete is that the incumbent be required to provide new entrants, end-to-end digital transmission without intervening conversion to analog for loops served by IDLC. The digital cross-connection functionality permitting end-to-end digital transmission is a "key attribute" provided by GR-303 for IDLC

NGDLC Capabilities for the Forward Looking Local Competition Environment

There are two important capabilities that NGDLC (GR-303 compliant IDLC) provides to support an environment which will allow local competition to develop through the use of unbundled network elements.

1. Multiple Switch Hosting

NGLDC supports multiple GR-303 interfaces.[3] This means that the NGDLC remote can be integrated with several switches as illustrated in Exhibit EMC2. The Bellcore GR-303 requires that the NGDLC be integrated with a minimum of

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[3] A GR-303 Interface consists of a 2-28 DS1s. DS1 ("digital speed one") is the basic digital signal which has 24 timeslots, or DS0s ("data speed zeros" , or voiceband channels). A minimum of 2 DS1s is required to provide for redundancy for the EOC (Embedded Operations Channel) and the TMC (Timeslot Management Channel) used to provide for communications between the switch and the remote, and for assignment of timeslots on a per-call basis, respectively). Provision of this redundancy (duplicating the EOC and TMC channels in two DS1s) ensures that service is not interrupted in the event that a DS1 equipment failure occurs